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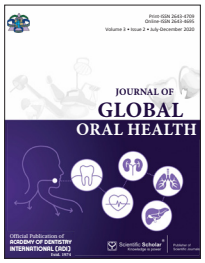

Research Article

An overview of teledentistry with a cross-sectional study on relevant knowledge and attitude of dentists in Mumbai

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Received : 23 June 2020
Accepted : 18 July 2020
Published : 19 November 2020

DOI
10.25259/JGOH_30_2020

Quick Response Code:

ABSTRACT

Objectives: Teledentistry is a relatively novel aspect, wherein digital telecommunication modalities are effectively employed for transferring data such as images and videos between dental professionals and patients that are physically separated across a distance. The concept could be essentially beneficial in improving the provision of oral health care to patients in rural areas and remote locations, especially in situations such as the present COVID-19 pandemic.

Materials and Methods: Dental professionals having at least a graduation degree (BDS) were considered eligible for the study. A self-constructed e-questionnaire comprising 15 questions was validated and then circulated online with the aid of messenger applications and emails to the eligible participants. The data were analyzed based on age, gender, qualification, and years of experience for the dentist-based survey using the Chi-square test.

Results: Our results indicate that only 55.6% of respondents had come across this relatively novel concept of digitalized health care provision with only 43% being aware of the modalities that can be utilized for the same. A significant portion (70–80%) of the respondents supported the utility of teledentistry in various specialization branches of dental practice.

Conclusion: Despite multiple benefits of teledentistry in various aspects of the field of dental practice and education, its use is still limited due to relative unawareness. With the present technology available across dental clinics even in rural areas, it is now more feasible and simpler to incorporate teledentistry into one's dental practice subsequently improving the quality of the oral health care system.

Keywords: Telemedicine, Oral health, Oral diagnosis, Public health dentistry, Continuing dental education

INTRODUCTION

The concept of telehealth or telemedicine involves the utility of electronic telecommunication devices to transmit videos, audio, and images for the provision of health care facilities, wherein the participants involved are physically separated over a distance.[1] It employs telecommunication technology, digital imaging, and the Internet to provide teleconsultation, exchange health information, and maintain electronic health records across long distances.[2] A similar application of this concept in the field of dentistry is known as "Teledentistry." Cook (1997) had defined teledentistry as "the practice of using video conferencing technologies to diagnose and provide advice about treatment over a distance."[3]

Teledentistry has been practiced in various developed countries throughout the world; however, its use in India is quite limited. This could be possibly due to a lack of awareness and knowledge

among dental practitioners regarding its use in daily practice. Even so, a significantly major portion of Indian population resides in rural areas and remote locations, rendering it imperative for commencement and inclusion of teledentistry across the country.

In addition, in the wake of COVID-19 pandemic, where social distancing norms are mandatory to be followed, teledentistry could certainly be used as an efficient and effective tool to obtain distant consultancies from specialized professionals of various branches of dentistry.[4] Herein, yet another application of this concept in such situations could be in the formal online education of the dental students, which may comprise either of the two modalities: Web-based self-instruction and interactive video conferencing.[5] It can also be used as a tool for continual dental education of the professionals to keep them up-to-date with advances in the field of practice.[6]

In this context, we aimed to assess the knowledge and attitude of dentists in the city of Mumbai regarding teledentistry by means of an e-questionnaire survey. The study would achieve the objectives to evaluate the awareness of dental professionals regarding the applicability and feasibility of a relatively novel concept of teledentistry and their recognition of its potential in the field of dental practice.

MATERIALS AND METHODS

A self-constructed questionnaire of 15 questions (attached as annexure 1), which was pilot tested for face and content validity with a team of four researchers, including a public health expert. The questionnaire was prepared after a detailed search of published data available with respect to teledentistry in the fields of tele-education, tele-diagnostic, teleconsultation, and telemonitoring. A total of 20 respondents participated in the pilot study, the data of which were not included in the final study. The reliability of these questions was tested using Cronbach's alpha analysis. A Cronbach's alpha value of 0.895 indicated a good internal consistency and validity. A self-constructed questionnaire was constructed using Google form. Dentists with BDS and MDS degree were included in this survey. Online platforms such as emails, WhatsApp, and other social media were utilized for distribution. The participants were encouraged to share the survey to their contacts as well, for increasing the participation and response rate of the questionnaire. The link was forwarded to many people.

Sample size

The sample size was determined using a single proportion formula

$$n = \frac{1.96^2\, p(1-p)(DEFF)}{d^2}$$

Where p = Estimate of the expected proportion, d = Desired level of absolute precision

Assuming the current prevalence/event rate to be at least 10% and keeping 5% confidence limit, for $p = 0.05$

$$n = 138$$

It was estimated that 138 respondents should complete the survey. The respondents were sampled by utilizing a purposive sampling method [Figure 1].

Statistical procedures

The filled responses obtained from the online platform were transferred into a Microsoft Office Excel Sheet (v 2010, Microsoft Redmond Campus, Redmond, Washington, United States). The compiled data were subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS v 21.0, IBM). Descriptive statistics such as frequencies and percentage for categorical data and mean and SD for numerical data have been depicted. A comparison of frequencies of categories of variables and responses with demographic variables was done using Chi-square test. For all the statistical tests, $P < 0.05$ was considered to be statistically significant, keeping α error at 5% and β error at 20%, thus giving a power to the study as 80%.

RESULTS

The total number of respondents was 151, of which 52 were male and 99 were female with age ranging from 22 to 65 years with a mean age of 25.72 years. The minimum eligibility criteria were having an educational qualification of at least a graduation degree (BDS). A total of 116 of the eligible respondents had a BDS degree and 35 respondents had an additional qualification of MDS.

With the advent of newer technologies in every aspect of human life, we are now in an era wherein the people are not merely using technology but "living technology." The field of dentistry has improvised drastically over the last century ever since its inception and incorporation of the latest technologies have always led to a more efficient provision of care to the patients. However, our results indicate that only 55.6% of respondents had come across this relatively novel concept of digitalized health-care provision with only 43% of respondents being aware of the modalities that can be utilized for the same. A statistically significant difference was found for the frequencies between the groups ($P < 0.01$, 0.05) with a higher frequency of BDS professionals being unaware of the various technologies involved in teledentistry as compared to those with MDS qualification [Table 1]. On illumination of the utility of the modality in various aspects of dentistry, the frequency of respondents confident with respect to these is summarized in [Figure 2], each of which aspect is subsequently discussed hereafter.

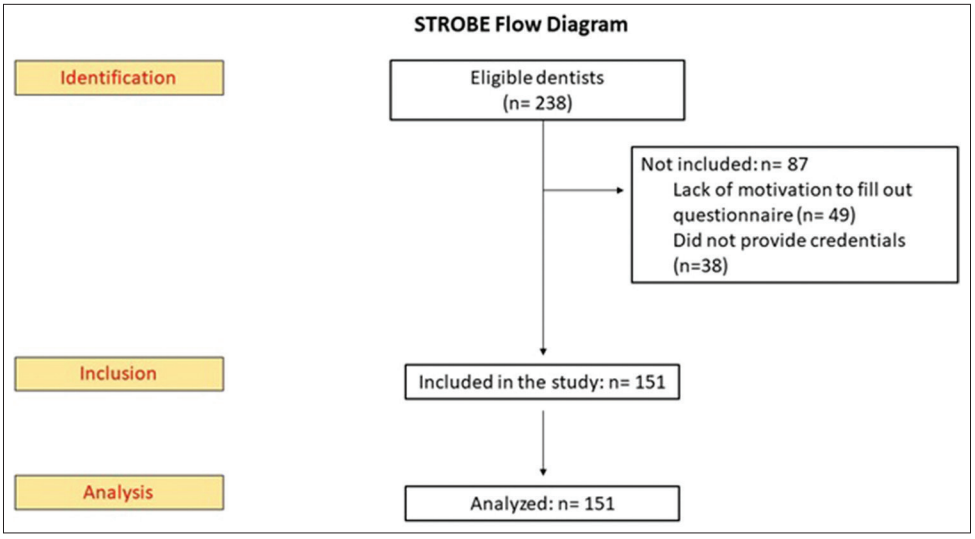

Figure 1: Outlines the procurement of 'n' responses for inclusion and analysis in the study.

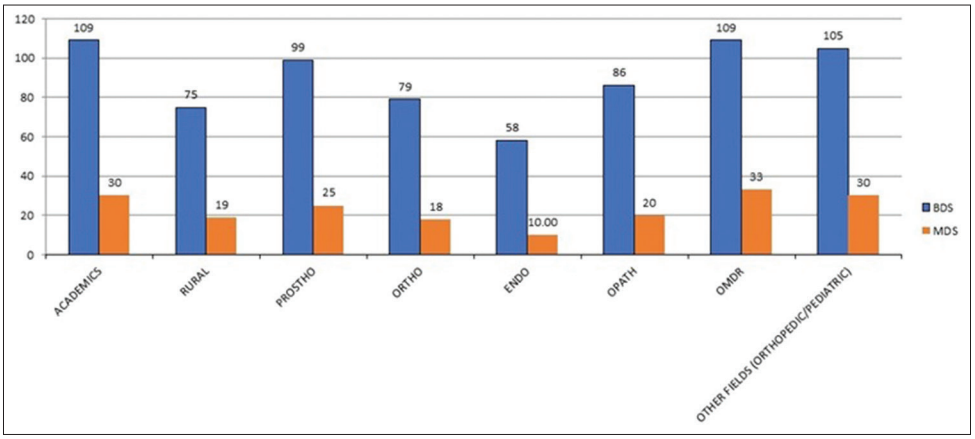

Figure 2: Summarizes the confidence of respondents about utility of teledentistry in various aspects of the field of dentistry.

Table 1: Demonstrates statistically significant difference between BDS and MDS respondents regarding their awareness of various modalities utilizable in teledentistry.

	Present qualification		Total	Chi-square value	*P*-value of chi square test
	BDS	MDS			
Q3					
No	73	13	86		
Yes	43	22	65	7.293	0.007**
Total	116	35	151		

DISCUSSION

American Dental Association has come up with four modalities for teledentistry, including Live video (synchronous), Store-and-forward (asynchronous), Remote patient monitoring (RPM), and Mobile health (mHealth).[7] The synchronous approach is a real-time, two-way interaction between a patient and a provider, or between providers themselves, usually accomplished through video. The asynchronous method involves the transfer of data (radiographs, intraoral imaging, video, and charting) to a dentist for the purpose of remote evaluation and diagnosis of the patient. Recent studies have found out that messenger apps such as WhatsApp messenger are the most frequently used synchronous modality by the physicians as well as the patients due to their relatively simpler and user-friendly interface.[8] Apart from messenger apps, various video conferencing apps and smartphone applications that enable transmission of data in the form of images or videos can be effectively employed.

Role of teledentistry in continual dental education

The field of dentistry is linked to a continuous stream of developments in technologies and treatment protocols. It,

thus, becomes incumbent on the part of a dentist as a health care professional to constantly remain up-to-date with these developments. Continuing Dental Education programs organized by various health authorities play a significant part in this process. Especially in situations such as the present COVID-19 pandemic, academic delays associated with psychological detriments in college students that have been reported in the literature.[9] At present, smartphone and internet facilities being available with most of the individuals and the younger generation is generally well-acquitted with various smartphone applications.[10] Health-care authorities could develop online portals, web-based education modules, or smartphone-based applications for continual dental education and teaching activities. Academic activities for postgraduate students such as journal clubs and seminars may be continued regularly through digital platforms that allow online meetings such as Microsoft Teams (Microsoft Redmond, WA), FaceTime (Apple Inc., Cupertino, CA), GoToMeeting (LogMeIn, Inc., Boston, MA), Webex (Cisco Webex, Milpitas, CA), and Zoom App (Zoom Video Communications Inc. San Jose, CA).[11] According to our results, it was agreed upon by 98% of BDS and 71.4% of MDS that teledentistry could be beneficial in maintaining a smooth curriculum by enabling online platforms for academic activities in the present pandemic situation.

Role of teledentistry in provision of oral healthcare in rural areas

In a developing country such as India, wherein a significant majority of the population (68.84%) resides in the rural areas,[12] emphasis is warranted to be laid on the provision of prompt diagnosis and treatment in these areas. Unfortunately, only 10% of dental professionals are available to provide oral care in these areas.[13] Furthermore, these areas face additional problems such as fluctuant supplies of electricity and the availability of resources such as dental materials. Furthermore, it has been found that the populations in rural areas tend to neglect their oral health due to a lack of awareness and education.[14] Therefore, it is imperative that the importance of oral health care is propagated to these areas, simultaneously ensuring that adequate diagnostic and treatment facilities are also provided. Despite the numerous technical challenges, most of the dental clinics, at present, invariably have access to smartphones and internet facilities which comprise the basic necessities for the purpose of teledentistry.[15] This was agreed on by 62.3% of respondents in our study that teledentistry could be essentially beneficial for the provision of prompt diagnosis in rural areas, while 76.2% of respondents agreed that the basic requirements could be met even in rural areas.

Role of teledentistry in provision of improved clinical care

The field of dentistry is relatively vast and involves numerous specialty branches. At times, a general dentist may not find himself in a position to accurately diagnose and devise a treatment plan for a particular case and would require an opinion from dental professionals having greater experience or specialty expertise. Teledentistry could bridge in this gap of experience and enable relatively inexperienced dentists to obtain guidance from more experienced professionals which would subsequently improve the quality of oral health care provided to the patients.[16] Our results are in accordance with these findings, wherein 86.8% of respondents were of the opinion that teledentistry could lead to an improved diagnosis as compared to that provided by a single dentist. Minor complications are often encountered by a professional in dental clinics and handling these usually require experience, in which relatively younger professionals might be lacking. In such situations, guidance can be sought for handling such emergencies or complications through teledentistry which was supported 86.1% of respondents.

In diagnostic radiology of oral lesions

Radiographs form an integral part in the diagnosis of oral lesions, especially those present intraosseously within the jawbones. Accurate radiographic interpretation is of utmost importance when dealing with various pathologies involving oral and maxillofacial structures. The entirety of the treatment plan and subsequent prognosis of the patient depends on a speedy and accurate diagnosis of pathologies such as intraosseous malignancies.[17] However, radiographs can often be tricky to interpret which is where it becomes mandatory to consult an oral radiologist. The previous studies have reported that there was no significant difference in diagnosis by observers when viewing lesions on a radiograph with digital panoramic images and by conventional lightbox method.[18] It has also been reported that teledentistry could lead to less amount of time-lapse in treatment for pathological conditions such as temporomandibular disorders as compared to conventional consultancy.[19] In our study, the fact that teledentistry could essentially lead to improved radiographic diagnosis by seeking advice from a radiologist was reinforced by agreement of 94% of respondents.

In endodontics

Location of root canal orifices is one of the most challenging aspects of dental treatment that requires adequate experience to meticulously determine their relative positions and numbers in a tooth during root canal treatment. Failure to locate a canal could lead to re-infection and subsequent endodontic failure.[20] Inexperienced dentists often struggle to locate the canals and in the absence of a guide, teledentistry could aid in seeking guidance from an endodontist. Existing literature provides evidence that root canal orifices could be competently located in mandibular molars by photographic modality.[21] Another study emphasized that the store and

forward method of telemedicine is an acceptable alternative to the traditional visual-tactile examination which is commonly used for selection of cases for endodontic treatment.[22] However, our results indicate that only 45.1% of respondents were confident enough that teledentistry could aid in this aspect. These findings could point out a relative unawareness of the dental practitioners toward the potential of teledentistry.

In oral and maxillofacial pathology

The practice of dentistry is not only confined to the teeth but also extends to other oral structures such as the buccal mucosa, tongue, gingiva, and palate. Frequently, different types of lesions may occur on these sites which may be difficult to diagnose by a general dentist. Web-based courses as a part of teledentistry have been recommended in the continual education of dental professionals in the understanding of these lesions.[23] Early diagnosis and prompt treatment of such lesions could have a tremendous impact on the vitality, psychology, and financial well-being of a patient.[24] A study by Torres-Pereira *et al.* found that almost 88% of cases that were referred to multiple consultants for distant diagnosis provided a correct diagnosis.[25] Another challenge faced by pathologists and surgeons is to accurately delineate the biopsy area during the procedure and during the grossing of the specimen in the histopathology laboratory. The microscopic diagnosis of the specimen may differ based on which area of the lesion is included in the biopsy and its exact depth.[26] With the aid of teledentistry, it could definitely be possible for the pathologist to coordinate with the surgeon in determining the most appropriate site and depth for biopsy of the lesion. Our results reinforce this fact, wherein 70.2% of the respondents supported teledentistry as a modality for improving the coordination of surgeons and pathologists in determining the biopsy site for a pathologic lesion.

In prosthodontics

Certain oral rehabilitation cases are complex enough to diagnose and determine a treatment plan by relatively unexperienced dental graduates. In such cases, teledentistry has been reported as beneficial for obtaining diagnosis by experienced prosthodontists.[27] Similar to the relation between an oral surgeon and an oral pathologist, active coordination between a prosthodontist and a laboratory technician can greatly improve the quality and compatibility of prosthesis provided to the patient.[28] Video conferencing and image modality communication between a prosthodontist and laboratory technician could resolve any existing discrepancies or doubts with regard to formulating a prosthesis, subsequently providing a prosthesis of superior quality. The previous work in this aspect has reported that telecommunication-aided overdentures were of superior quality as compared to those made with conventional protocols in rural areas.[29] Our results are in accordance with these previous findings, wherein 82.1% of respondents agreed that teledentistry could enhance the quality of prosthetic work by enabling better communication between laboratory technician and dentist.

In orthodontics

In the field of orthodontics, it can be used for consultation, referral purposes, diagnostic purposes, outline treatment protocol, and interceptive appliance fabrication.[30] A special branch of teledentistry named tele-orthodontics has flourished in many developed countries.[31] Daniel *et al*., in a systematic review, outlined that teledentistry can be used for assessment of malocclusions including open bite, overjet, overbite, bilateral Class III molars, maxillary incisor irregularity, and posterior cross-bite.[32] It can also be used for handling orthodontic complications or corrections in cases of distant consultancies.[33] In our study, 64.2% of dental practitioners found that teledentistry could be used as a tool for orthodontic diagnosis and referral.

Technical skills for teledentistry

The belief that practicing teledentistry would require a dental professional to acquire additional technical skills could be another factor responsible for holding back dentists to venture into this relatively novel and potentially overlooked field of dentistry. Our results indicate 49% of respondents opined that additional moderately complex level of technical skills need to be acquired by a dental professional to practice teledentistry, while 41.1% were of the view that these skills required would be relatively simpler [Figure 3]. The previous studies have reported that the minimal requirements for practicing acceptably efficient teledentistry comprise a smartphone and Internet.[34] Fortunately, most of the modern-day dental clinics are acquitted with these basic requirements and the professionals are proficient with their use as well,

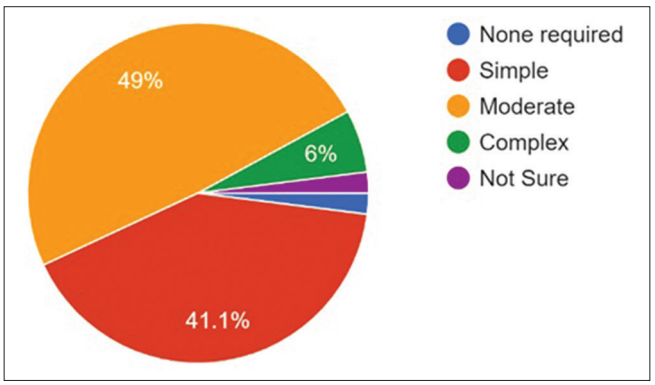

Figure 3: Illustrates frequency of responses for additional technical skill requirement to be acquired by a dentist in order to incorporate teledentistry into one's clinical practice.

making it fairly feasible to incorporate teledentistry into one's clinical practice.

CONCLUSION

The numerous benefits of teledentistry in improving the quality of dental care in almost every aspect of dentistry, which is backed up by adequate scientific literature, should not be overlooked. The issues barring the inclusion of teledentistry into one's clinical practice, such as relative unawareness of the concept and myths about its technical requirements, need to be addressed earnestly. Our study results confer that although most of the dental professionals believe teledentistry could be beneficial in education and diagnosis, not many are aware of its potential in various possible applications that would greatly augment the quality of dental care provided to the patients. Such applications make teledentistry a quintessential modality in the provision of oral health care and education in the current pandemic situation. Thus, teledentistry allows collaboration of various dental professions and elaborating the age-old fundamental of multidisciplinary approach by enhancement through use of digital technology, giving it a new outlook.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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How to cite this article: Save SS, Singh SS, Kalra DD, Jhaveri ST, Avhad SK. An overview of teledentistry with a cross-sectional study on relevant knowledge and attitude of dentists in Mumbai. J Global Oral Health 2020;3(2):101-9.

SUPPLEMENTARY MATERIAL

Assessment of knowledge and attitude of dentists in India related to teledentistry – An e-questionnaire survey

Kindly mark appropriate answers. All the information provided will be kept confidential. We, Department of Public Health Dentistry, YMT Dental College and Hospital, thank you for your valuable time and support. Kindly mail us in case of any queries at: siddheshsawe@gmail.com

Teledentistry is defined as "the use of electronic communication and information technologies to provide or support clinical care at a distance."

Demographic data:

- Age
- Gender
- Field of work
- Private practice
- Institutional: Govt College Private College
- Qualification
- Experience – (in years).

For post graduates (current status of curriculum):

- Part I
- Part II
- Part III.

Section II:

1. What aspects do you think teledentistry will be useful in the field of dental practice and academics?
   - Gain knowledge from foreign delegates by means of webinars
   - Patient diagnosis/screening
   - Obtaining opinion from a specialty dental professional (e.g.: Orthodontist)
   - Patient referral to specialty dental professional
   - All of the above
   - None of the above.
2. Have you come across the use of telecommunication for the purpose of diagnosis/screening of any patient in your practice/institution?
   - Yes
   - No.
3. Are you aware of any applications/technology that are used in teledentistry for patient monitoring/screening?
   - Yes
   - No.
4. Do you think teledentistry will be beneficial for prompt diagnosis of oral lesions of patients in rural areas that have limited access to oral health care?
   - Yes
   - No
   - Not sure.
5. Do you think practitioners in rural areas will be able to access at least minimal technology required for teledentistry, that is, Internet, phone/computer?
   - Yes
   - No
   - Not sure.
6. Do you think teledentistry can enhance quality of prosthetic work by facilitating visual communication between dentist and laboratory technician?
   - Yes
   - No
   - Not sure.
7. Can teledentistry be utilized for consulting the orthodontists by a general dentist to deal with certain issues of patients undergoing orthodontic treatment?
   - Yes
   - No
   - Not sure.
8. Can teledentistry be utilized by a general dentist for canal location by seeking help from endodontist?
   - Yes
   - No
   - Not sure.
9. Can teledentistry be utilized by a dentist/surgeon for obtaining guidance relevant to biopsy site from a pathologist?
   - Yes
   - No
   - Not sure.
10. Will it help general dentist for seeking advice for radiographic opinion from more experienced professionals/radiologists?
    - Yes
    - No
    - Not sure.
11. Can teledentistry be utilized by a dentist/surgeon for collaborating with doctors from other fields such as pediatricians, orthopedic doctors, etc.?
    - Yes
    - No
    - Not sure.
12. Do you think minor complications encountered by a relatively unexperienced dentist could be resolved

by obtaining guidance from a relatively experienced professional using teledentistry?
- Yes
- No
- Not sure.

13. Do you think teledentistry would lead to better diagnosis and provision oral care as compared to that diagnosed by a single dentist?
    - Yes
    - No
    - Not sure.
14. Do you think teledentistry would be essentially beneficial in times of situations like the present COVID-19 pandemic for academic and diagnostic purposes?
    - Yes
    - No
    - Not sure.
15. What level of additional technical skills would a dentist need to acquire for inclusion of teledentistry into his academic/practice?
    - None required
    - Simple
    - Moderate
    - Complex
    - Not sure.